Full-Immersion Air Traffic Control Tower Simulation

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NASA's FutureFlight Central is the world's first full-scale, full-immersion airport-surface simulation environment in which the safety and efficiency of new technologies and procedures can be researched, developed, and evaluated under various airport conditions. Construction of this innovative new Ames facility was completed and the facility formally dedicated with a ribbon-cutting ceremony on 13 December 1999.

FutureFlight Central (FFC) consists of a two-story physical structure replicating a full-scale air traffic control tower, including work areas to support pilots, ramp controllers, and airport operators along with FFC simulation engineers, software developers, and researchers. It is equipped with air traffic control simulation software components and a digital voice, a simulated radio/telephone/intercom system, a data communication network, and audiovisual equipment to support the simulations. The tower cab (fig. 1) features programmable user displays and a virtually seamless, visual display system consisting of screens and projectors that provide a 360-degree out-the-window field of view driven by the air traffic control simulation software and image generators.

The FFC staff successfully completed the first simulation for a paying customer when the Boeing Corporation completed a human factors study in the facility at the end of May 2000. For this very first simulation in the FFC, Boeing gave the FFC staff extremely high marks in its debrief survey. The staff received scores of 10 out of a possible 10 on every item except two, on which it received scores of 9.

In June 2000, San Francisco International Airport entered into an agreement with FFC to simulate and preview new tower locations associated with its potential runway reconfiguration. And in August 2000, Los Angeles International Airport and United Airlines

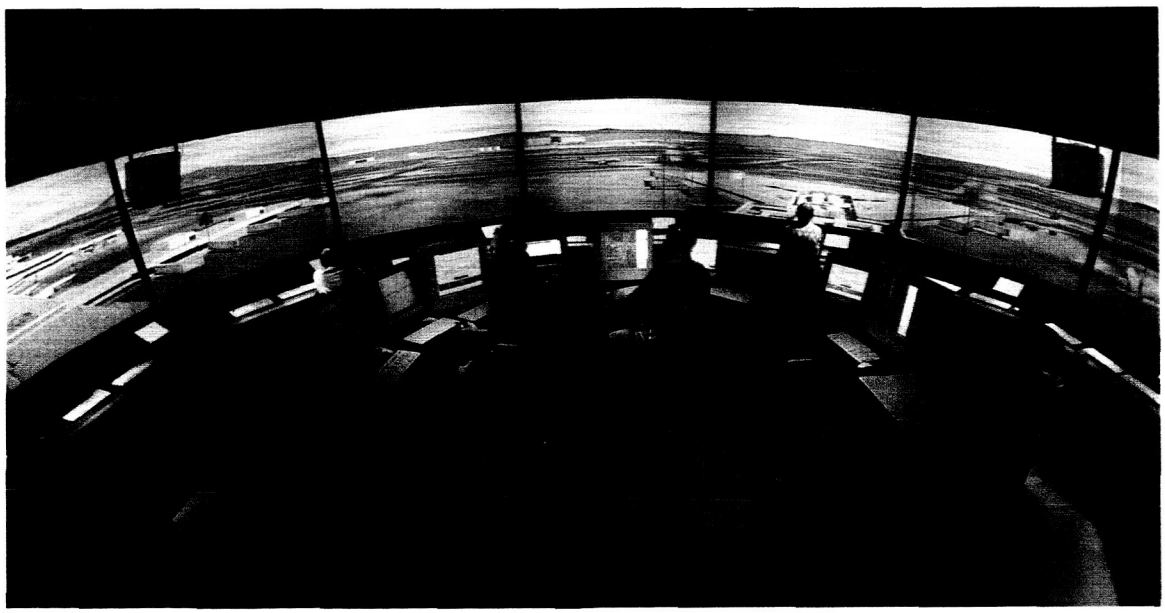

Fig. 1. FutureFlight Central air traffic control tower cab.

signed a contract to include FFC in a joint study of runway incursions. These major U.S. airports are the first to benefit from Future-Flight Central, a world-class airport operations simulation facility designed to advance the safety, efficiency, and cost effectiveness of current and future airport procedures, design, and technologies.

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Direct-To Tool for En Route Controllers

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A new tool that helps air traffic controllers improve the efficiency of trajectories has been developed by researchers at Ames Research Center. The tool, called Direct-To, identifies all the aircraft in a region of airspace that can reduce their time of flight by choosing more direct routes than those originally planned. It was designed to help reduce routing inefficiencies resulting from the fixed highway-in-the-sky route structure and other operational constraints imposed by air traffic control. The software for the tool has been completed and was integrated into the Center-TRACON Automation System (CTAS), which comprises a suite of tools for air traffic controllers. The tool is scheduled for operational tests in mid-year 2001 at the Fort Worth Air Route Traffic Control Center. In preparation for the field test, the tool has been operated at Ames in shadow mode with live air traffic data received from the Fort Worth Center. It has also undergone extensive simulator evaluations with controllers in the loop.

The algorithm in Direct-To first computes four-dimensional trajectories along the planned flight plan routes for all aircraft tracked by radar in a Center's airspace. Then it computes a direct-to trajectory, also referred to as a great circle route, to a trial direct-to way point on the aircraft's flight plan. Finally, it compares the times of the original and the direct-to trajectories leading to the trial direct-to way point where the two trajectories rejoin. If the direct-to trajectory shows at least a 1-minute time saving over the original trajectory, the aircraft is added to the Direct-To list. This list, which is displayed on the controller's monitor, contains the identifiers of all such aircraft found by the algorithm, ordered by the amount of the time saving, with aircraft showing the greatest saving placed at the top. In addition to finding all aircraft eligible for direct-to flight plan changes, the algorithm analyzes the proposed direct-to route for potential conflicts. If a conflict is predicted to occur, the time to the conflict is added to the list.

The controller interface for Direct-To is based on graphical user interface techniques incorporated in personal computers. It makes extensive use of point-and-click mouse inputs and on-screen graphics and buttons to minimize controller workload. For example, it requires only two mouse clicks to make a direct-to flight plan change, rather than the more than 10 keystrokes a controller has to enter to make the same change in today's system. This reduction in workload, combined with the accurate identification of the most time-saving and conflict-free direct-to trajectories, will make it possible for controllers to issue direct-to clearances to pilots more frequently, thereby yielding substantial cost savings to aircraft operators.